Box # HH-1-1-6

ChemRisk/Shonka Research Associates, Inc., Document Request Form

1 Item 6

(This section to be completed by subcontractor requesting document)

J. Lamb / SRC
Requestor / Document Center (is requested to provide the following document)

Date of request 07/25/96 Expected receipt of document 08/09/96

Document number 1) Unnumbered - 10/14/86
2) ORNL/ESH-1/V21 Date of document ~~ORNL~~ 9/86

Title and author (if document is unnumbered) 2 Items
1) Comments on the Resource Management Plan for the ORR Vol 21
Letter with Enclosure to L.H. Jordan
2) Resource Management Plan for the ORR Vol 21 (Draft)

(This section to be completed by Document Center)

Date request received 7/29/96

Date submitted to ADC Item 1 - 7/29/96

Date submitted to HSA Coordinator 7/29/96

(This section to be completed by HSA Coordinator)

Date submitted to CICO Item 1 - 7/29/96

Date received from CICO 8/5/96

Date submitted to ChemRisk/Shonka and DOE 8/5/96

(This section to be completed by ChemRisk/Shonka Research Associates, Inc.)

Date document received

Signature

Item 2 to Linda Hill for processing. 7/29/96 Thornton

1650

From box # HH-1-1-6

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

October 14, 1986

R. G. Jordan

Comments on the Resource Management Plan for the Oak Ridge Reservation, Volume 21

As requested in your letter dated September 23, 1986, enclosed are comments regarding the Resource Management Plan for the Oak Ridge Reservation, Volume 21: Water Conservation Plan for the Oak Ridge Reservation.

W. R. Golliher, K-1001, MS-134, ORGDP (4-7930) NoRC

WRG:JGR:shh

Enclosure

cc: J. G. Rogers - RC
W. J. Scheib
J. E. Shoemaker
File - WRG

This document has been approved for release to the public by:

Asst Technical Information Officer
Oak Ridge K-25 Site

8/11/96
Date

The Oak Ridge K-25 Site is managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy under contract DE-AC05-84OR21400.

ORGDP COMMENTS

Item	Page	Comments
1	vii	Figure 1 needs to show a water clarifier on the raw water stream. The clarifier removes suspended solids and allows softening.
2	viii	The ORGDP Water Treatment Plant's capacity is indicated to be 8 million gallons per day. This is true for the actual capacity of the plant, but the present pumping capacity only allows a flow of 4 million gallons per day.
3	x	Figure 4 should reflect the reduced capacity indicated in Item 2.
4	7	Again the capacity of the ORGDP Water Treatment Plant should reflect the reduced pumping capacity.
5	19	The storm drain survey will involve some characterization of the flows, but the main intent is to characterize the water quality.
6	29	In Section 5.3.3, Item 6, change the first line to read "Discontinue activities in the following areas":. Change "K-1232 chemical process": section into a bullet similar to the three other bullets under Item 6. Also add the consequence of shutting down this process to read "work curtailment".

W. J. Scheib
October 14, 1986

HALL, Joe	LOWE, Susan
PETERSON, Pete	
SHOEMAKER, John	SOMMERFELD, Ken

DESIRED ACTION

- ☐ Your Approval
- ☑ Your Comments
- ☐ Your File
- ☐ Your Information
- ☐ Initial and Pass On
- ☐ Prepare Reply for My Signature
- ☐ Prepare Report and Forward to this Office
- ☑ Please Handle
- ☐ Per Conversation
- ☐ See Me
- ☑ Note and Return
- ☐ Destroy
- ☐

REMARKS:

FROM W. R. Golliher **DATE** 9/25/86

UCN-230
(12356 4-

[redacted]

MARTIN MARIETTA

Internal Correspondence

W.R. GOLLIHER

SEP 25 11 08 AM '86

MARTIN MARIETTA ENERGY SYSTEMS, INC.

September 23, 1986

G. G. Fee
W. R. Golliher
R. S. Wiltshire

Resource Management Plan for the Oak Ridge Reservation, Volume 21

The attached draft report, Resource Management Plan for the Oak Ridge Reservation, Volume 21: Water Conservation Plan for the Oak Ridge Reservation, has been prepared by J. L. Kasten utilizing input from staff members of each of the Oak Ridge installations. DOE Order 4300.1A, Real Estate Management, requires the development of plans for soil, water, and plant conservation to be part of site development studies.

Your review of the draft with particular attention to the plant water curtailment plans for the installations in case of extreme drought conditions is suggested. We would appreciate your comments by October 14, 1986.

R. G. Jordan, 1000, MS-335, ORNL (4-1645)

RGJ/bh

cc: M. E. Mitchell
T. W. Oakes
L. H. Stinton

Comments: JJR (TC)
• Table of Contents does not agree with remainder of package. Example 3.3 in TC is 3.4 in report body.

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(This section to be completed by HSA Coordinator)

Date submitted to CICO Item 1 - 7/29/96 To ORNL 7/31/96
Linda Hill

Date received from CICO 7/31/96

Date submitted to ChemRisk/Shonka and DOE

(This section to be completed by ChemRisk/Shonka Research Associates, Inc.)

Date document received

Signature

Item 2 to Linda Hill for processing. 7/29/96 Thanks

MARTIN MARIETTA

Internal Correspondence

W.R. GOLLIHER

SEP 25 11 08 AM '86

MARTIN MARIETTA ENERGY SYSTEMS, INC.

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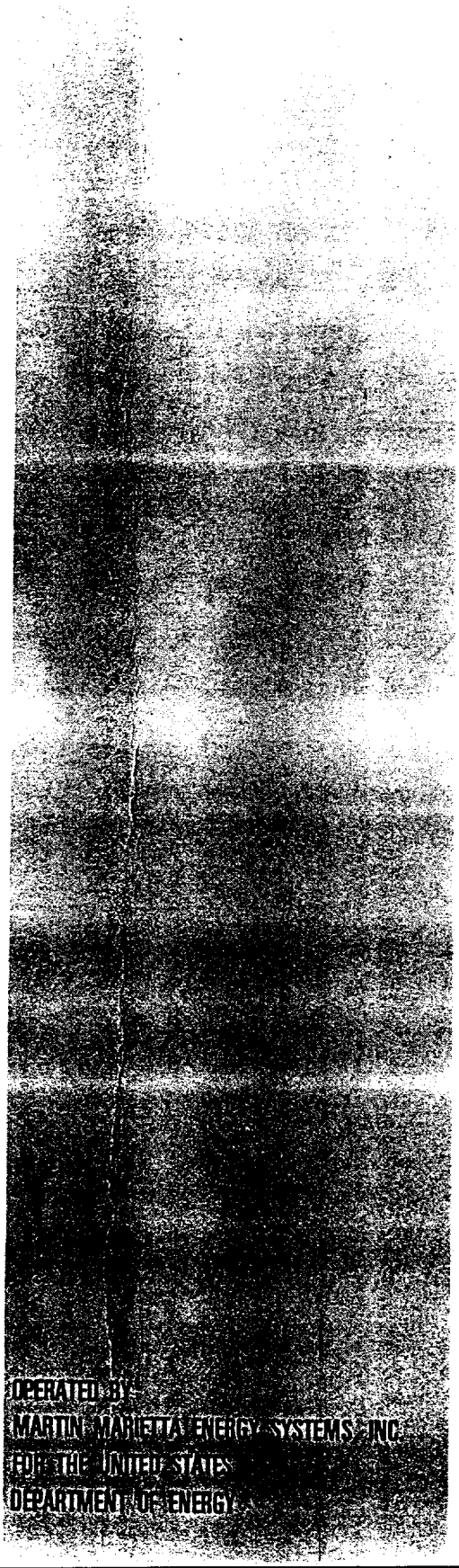
Note date

ORNL/ESH-1/V21

MARTIN MARIETTA



Resource Management Plan for the Oak Ridge Reservation

Volume 21: Water Conservation Plan for the Oak Ridge Reservation

J. L. Kasten

DRAFT

RESOURCE MANAGEMENT PLAN FOR THE U.S. DEPARTMENT OF ENERGY OAK RIDGE RESERVATION

ORNL-6026/V1	Management Plan Overview and Summary
ORNL-6026/V2	Aquatic Habitats
ORNL-6026/V3	Archeological Considerations
ORNL-6026/V4	Endangered and Threatened Plant Species
ORNL-6026/V5	Environmental Monitoring
ORNL-6026/V6	Forest Management
ORNL-6026/V7	Geography, Demography, Topography, and Soil
ORNL-6026/V8	Geology
ORNL-6026/V9	Health, Safety, and Environmental Affairs
ORNL-6026/V10	Hydrology
ORNL-6026/V11	Site Development
ORNL-6026/V12	Laws/Regulations/Guidelines
ORNL-6026/V13	Oak Ridge National Environmental Research Park
ORNL-6026/V14	Utilities
ORNL-6026/V15	Waste Management
ORNL-6026/V16	Wildlife Management
ORNL-6026/V17	Maps
ORNL-6026/V18	Forest Management Cost/Benefit Review
ORNL/ESH-1/V19	Inventory of Groundwater Wells
ORNL/ESH-1/V20	Soil Conservation Plan
ORNL/ESH-1/V21	Water Conservation Plan

ORNL/ESH-1/V21

Resource Management Plan

for the

Oak Ridge Reservation

Volume 21: Water Conservation Plan for the Oak Ridge Reservation

Date Published: September 1986

J. L. Kasten

Prepared by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
P.O. Box X
Oak Ridge, Tennessee 37831
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

CONTENTS

LIST OF ACRONYMS

BCK	Bear Creek kilometer
BCVWDA	Bear Creek Valley Waste Disposal Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRK	Clinch River kilometer
CWA	Clean Water Act
DOE	Department of Energy
EFPC	East Fork Poplar Creek
EFPCK	East Fork Poplar Creek kilometer
EPA	Environmental Protection Agency
ERK	Emory River kilometer
LLW	low-level liquid waste
MBK	Melton Branch kilometer
MOU	memorandum of understanding
MSL	mean sea level
NPDES	National Pollutant Discharge Elimination System
NRWTP	Nonradiological Waste Treatment Plant
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCK	Poplar Creek kilometer
PW	process waste
RCRA	Resource Conservation and Recovery Act
RCW	recirculating cooling water
SWSA	solid waste disposal area
TDHE	Tennessee Department of Health and Environment
TRK	Tennessee River kilometer
TVA	Tennessee Valley Authority
USGS	U. S. Geological Survey
WOC	White Oak Creek
WOCK	White Oak Creek kilometer

EXECUTIVE SUMMARY

The Water Conservation Plan for the Oak Ridge Reservation (ORR) is part of the site development study required by Department of Energy (DOE) Order 4300.1A to ensure that maximum benefit is derived from water resources and that they are protected. The planned management of this resource maximizes the efficiency of water use and preserves water quality. This Water Conservation Plan covers facilities within the ORR including the Y-12 Plant, Oak Ridge National Laboratory (ORNL), Oak Ridge Gaseous Diffusion Plant (ORGDP), the Industrial Park, the Scarboro Facility, Rust Engineering, and the Clark Center Recreation Area. The water balance for the ORR is summarized and plans for optimizing water usage and protecting water quality are included. Temporary measures to curtail water usage in the event of a drought are also summarized.

The Clinch River and its tributary system is the source of water supply for the ORR as well as the means for wastewater discharge. Total water intake for the ORR is shown in Figs. 1 and 2. Raw water is pumped from the Clinch River for fly ash sluicing at the Y-12 Plant [9.1 million liters (2.4 million gallons) per day] and

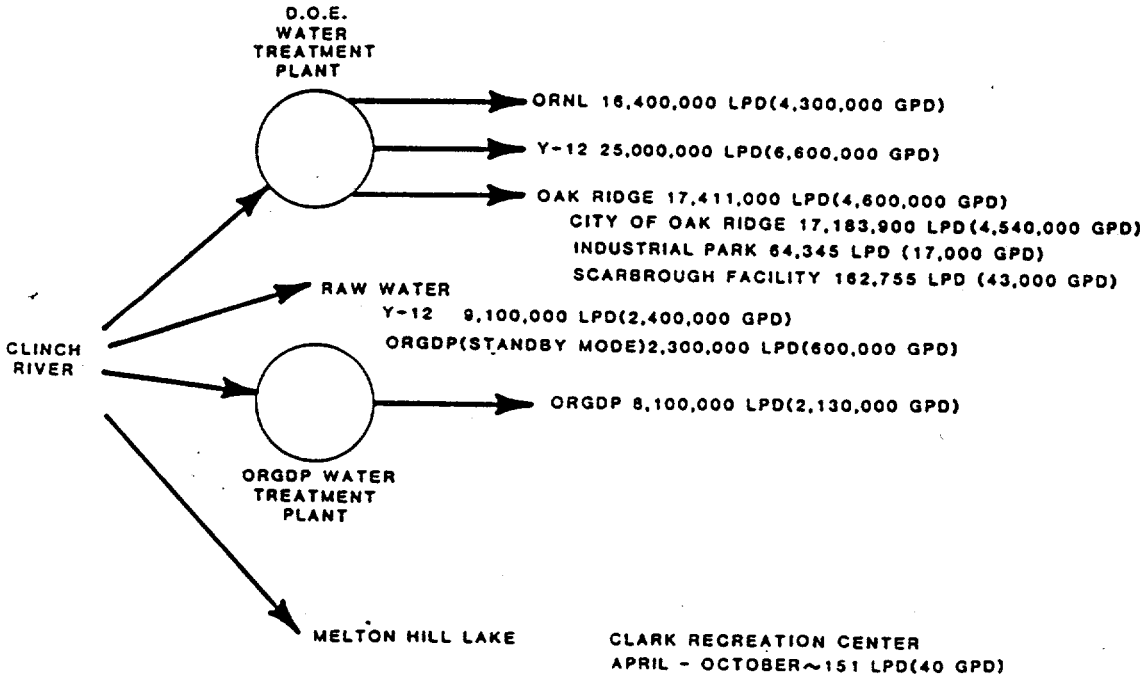


Fig. 1. Water intakes on the Oak Ridge Reservation.

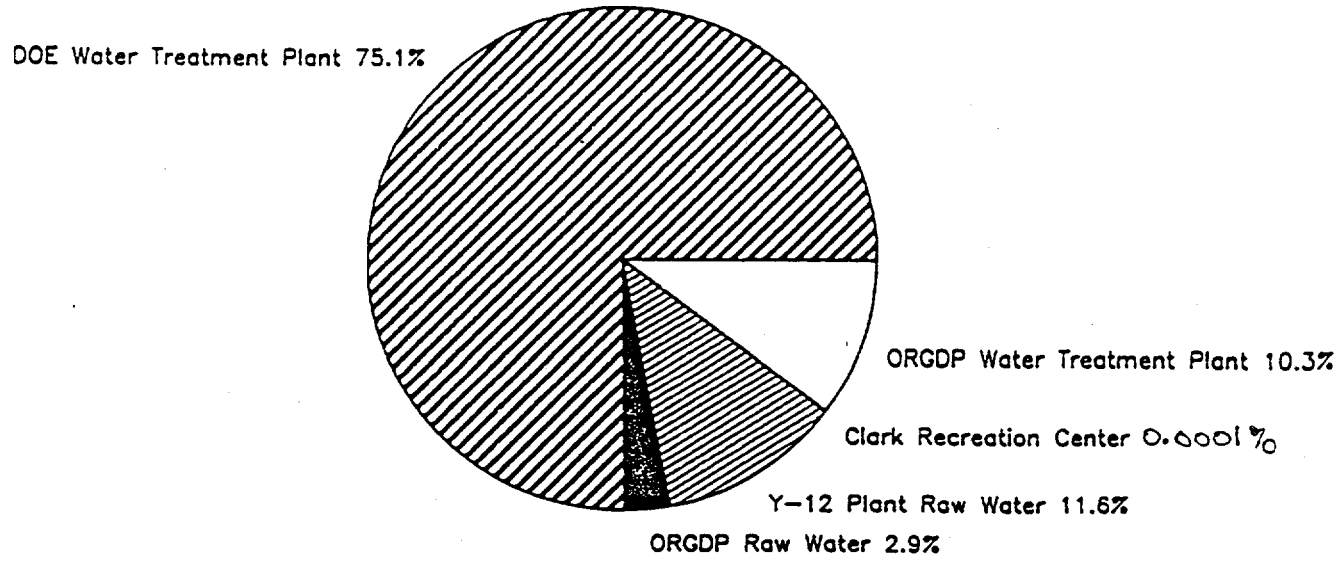


Fig. 2. Total water intakes--Oak Ridge Reservation.

for cooling makeup water and fire water at the ORGDP [2.3 million liters (0.6 million gallons)]. The DOE water treatment plant supplies treated water to ORNL, the Y-12 Plant including Rust operations, the City of Oak Ridge including the Industrial Park off Bear Creek Road, and the Scarboro Facility operated by Oak Ridge Associated Universities (ORAU). The treatment plant, operated by Rust Engineering for DOE, has the capacity for treating 106 million liters (28 million gallons) of raw water a day but currently treats only 58.6 million liters (15.5 million gallons) per day (see Fig.3). The Y-12 Plant usage rate for raw and treated water is 34 million liters (9 million gallons) of water per day. ORNL water use is approximately 16.3 million liters (4.3 million gallons) of water per day. Oak Ridge water usage is 17.4 million liters (4.6 million gallons) per day including 64,000 liters (17,000 gallons) per day for the Industrial Park and 163,000 liters (43,000 gallons) per day for the Scarboro Facility. The ORGDP water treatment plant has the capacity to treat 30.28 million liters (8 million gallons) per day; however, it currently treats 8 million liters (2.13 million gallons) per day. The average daily use of raw and treated water at ORGDP before the plant was placed in standby mode was approximately 60 million liters (15 million gallons) per day. At present, ORGDP total raw and treated water usage is approximately 10.2 million liters (2.7 million gallons) per day. Capacity levels for the DOE and ORGDP water treatment plants are shown in Fig. 4. The present total water usage for the ORR Energy Systems facilities is 60.5 million liters (16 million gallons) per day. The water usage at the ORR facilities does not show dramatic seasonal variations; however, the peak appears to occur during the late summer months. Water is available

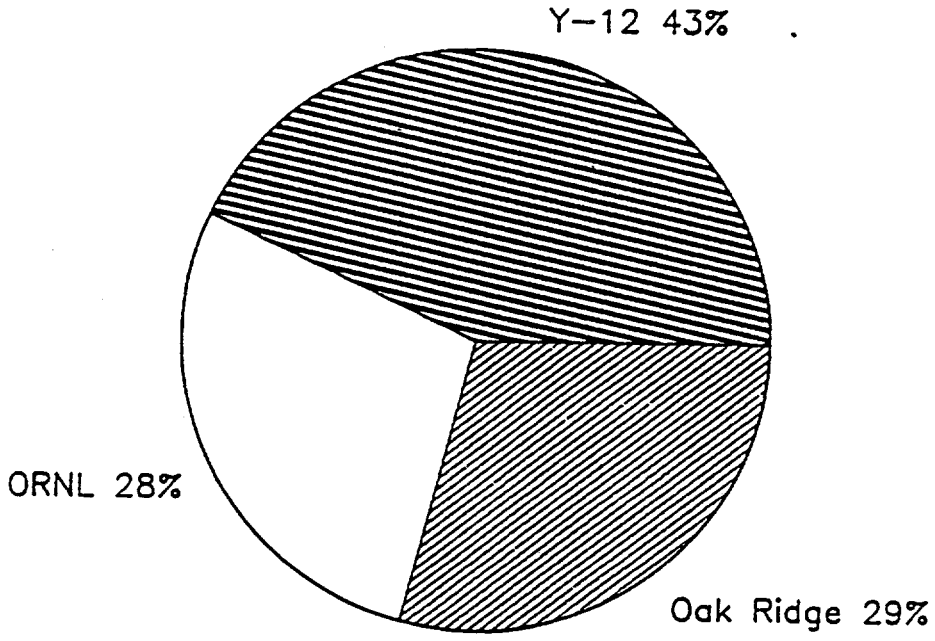


Fig. 3. DOE water treatment plant treated water usage.

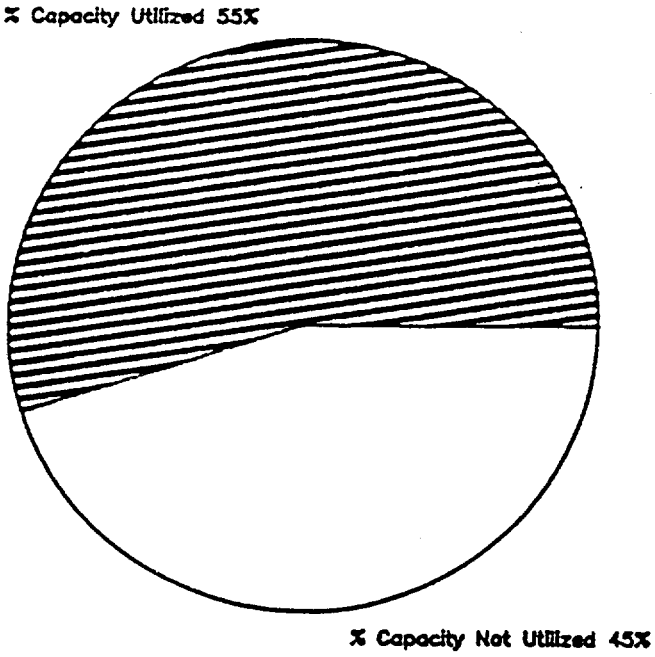
at the Clark Center Recreation Area from April through October with an average usage of 151 liters (40 gallons) per day.

Water usage at the ORR facilities includes makeup water for cooling purposes (cooling tower and once-through cooling water), water for process systems, sanitary water, and water for boiler feed and ash sluice at the steam plants. Cooling water accounts for over 50% of the water utilized at each plant as shown in the chart on Fig. 5. The water withdrawn from the Clinch River is either consumed by the processes, lost to the atmosphere as evaporation, or eventually discharged back to the Clinch either directly through tributary streams or indirectly by groundwater flow.

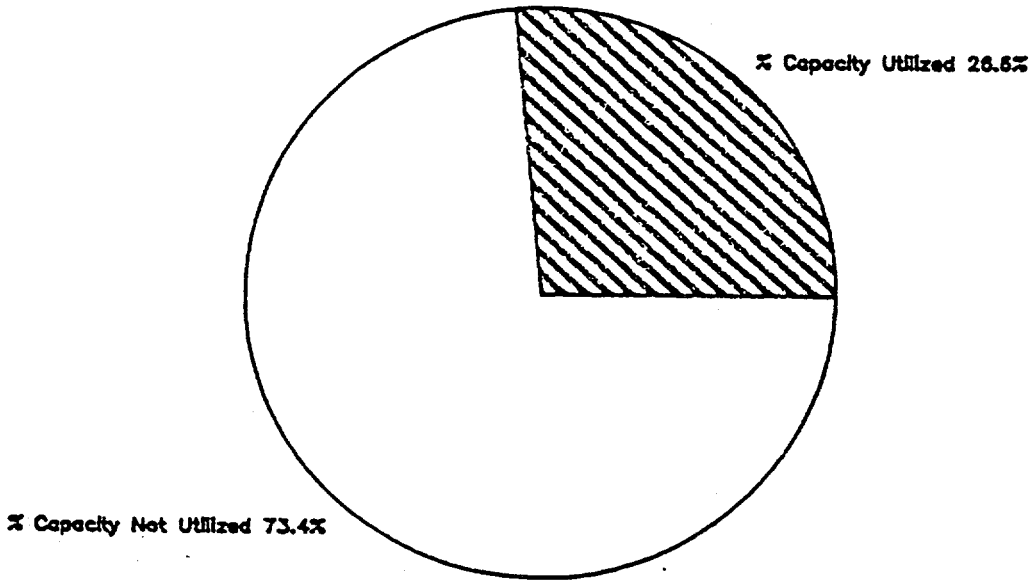
There are several potential options available for minimizing water use at the ORR facilities. These include controlling water line leakages, recycling effluents, reducing once-through cooling, and installing flow meters for accurate accountability of water use.

ORR Energy Systems facilities discharge 49,840,000 liters (13,140,000 gallons) per day of water to the Clinch River system. Figure 6 summarizes discharges within the ORR including discharges to the Oak Ridge sewage treatment plant.

Water quality can be affected by discharges from the three plants and by groundwater transport of pollutants from burial grounds and landfills. Surface water and groundwater end up eventually in the Clinch. Y-12 Plant wastewater is discharged either into Bear Creek or East Fork Poplar Creek, which joins Poplar Creek, a tributary of the Clinch River.



DOE Water Treatment Plant



ORGDP Water Treatment Plant

Fig. 4. Water treatment plants' capacity levels.

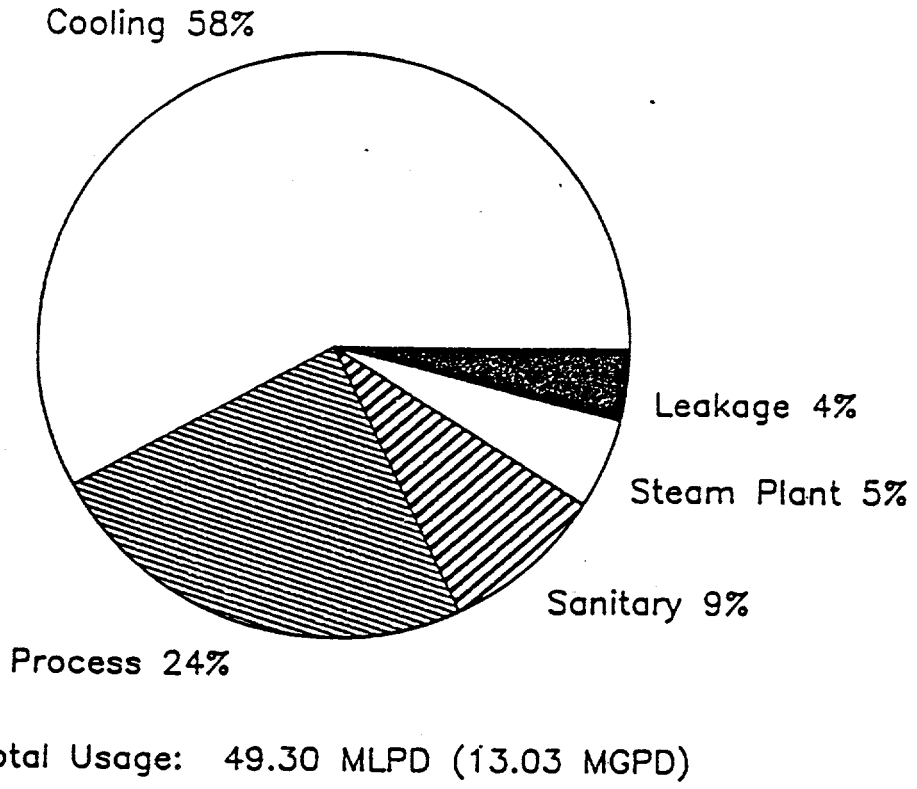


Fig. 5. Total water usage--Y-12 Plant, ORNL, and ORGDP.

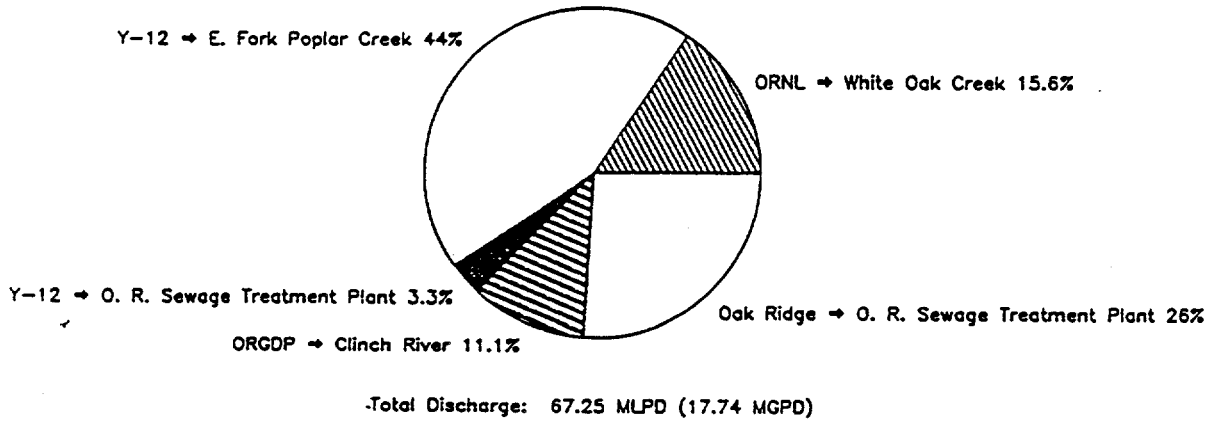


Fig. 6. Surface water discharges on the Oak Ridge Reservation.

ORNL wastewater is returned to the Clinch River via White Oak Creek. Effluents from ORGDP are discharged directly into the Clinch River or indirectly via Poplar Creek. Few streams on the ORR do not receive waste in some form, either as direct discharge, surface runoff, or groundwater discharge.

Programs are in place to preserve and protect water quality within the ORR.

These include the National Pollutant Discharge Elimination System (NPDES) permits, best management practice plans, and remedial action plans. The plan is to improve water quality through adequate characterization of effluents and wastes so that appropriate treatment, storage, disposal, or remedial action programs can be implemented. Monitoring wells provide information on groundwater quality so that an assessment can be made of the effectiveness of pollution control measures.

In the event of prolonged drought, water usage and waste discharge could be restricted. Curtailment measures range from elimination of water usage at nonessential facilities to the extreme case of supplying water for fire protection purposes only, which would result in plant shutdown. The curtailment of waste stream discharges to minimize environmental degradation would require a detailed review of each discharge stream. Preliminary plans for the major users (Y-12, ORNL, ORGDP) within the Reservation are summarized.

1. INTRODUCTION

The Water Conservation Plan addresses water management within the Oak Ridge Reservation including ORNL, the Y-12 Plant (including Rust Engineering), ORGDP, the City of Oak Ridge (including the Industrial Park), the Scarboro Facility, and the Clark Center Recreation Area. The plan focuses on (1) the available water resources, (2) the ORR water balance, (3) the protection of water quality, and (4) water management strategies including water conservation and drought management.

The Clinch River controls both groundwater and surface water hydrology and has generally provided an adequate water supply for ORR uses. Protection of water quality has been the thrust of many programs within the ORR. Water conservation strategies include efforts to maximize the efficiency of water usage and to preserve water quality. In the event of prolonged drought, restrictions of water usage may be necessary.

2. ORR WATER RESOURCES

The Oak Ridge Reservation comprises a series of small drainage basins through which small streams feed the Clinch River-Melton Hill reservoir. The Clinch River, with a drainage area of 11,427,000 km^2 (4412 $mile^2$), is the major source of water in the Oak Ridge area. Tributaries of the Clinch River include White Oak Creek, East Fork Poplar Creek, Bear Creek, and Poplar Creek. Water levels on the Clinch are regulated by releases from Norris Dam, Melton Hill Dam and Watts Bar Dam under Tennessee Valley Authority (TVA) jurisdiction. These fluctuations on the river affect the tributary streams and creeks draining the ORR. The Clinch and its tributary streams are shown in Fig. 7.

The White Oak Creek basin has a drainage area of 17,000 km^2 (6.53 $mile^2$). The flow rates observed for White Oak Creek range from 0 to 19 m^3/s (0 to 643 ft^3/s) at White Oak Creek km 0.96 (mile 0.6).[1] The headwaters of White Oak Creek originate on Chestnut Ridge north of ORNL. Before converging with the Clinch River, White Oak Creek flows into White Oak Lake, an 8-ha (20-acre) impoundment

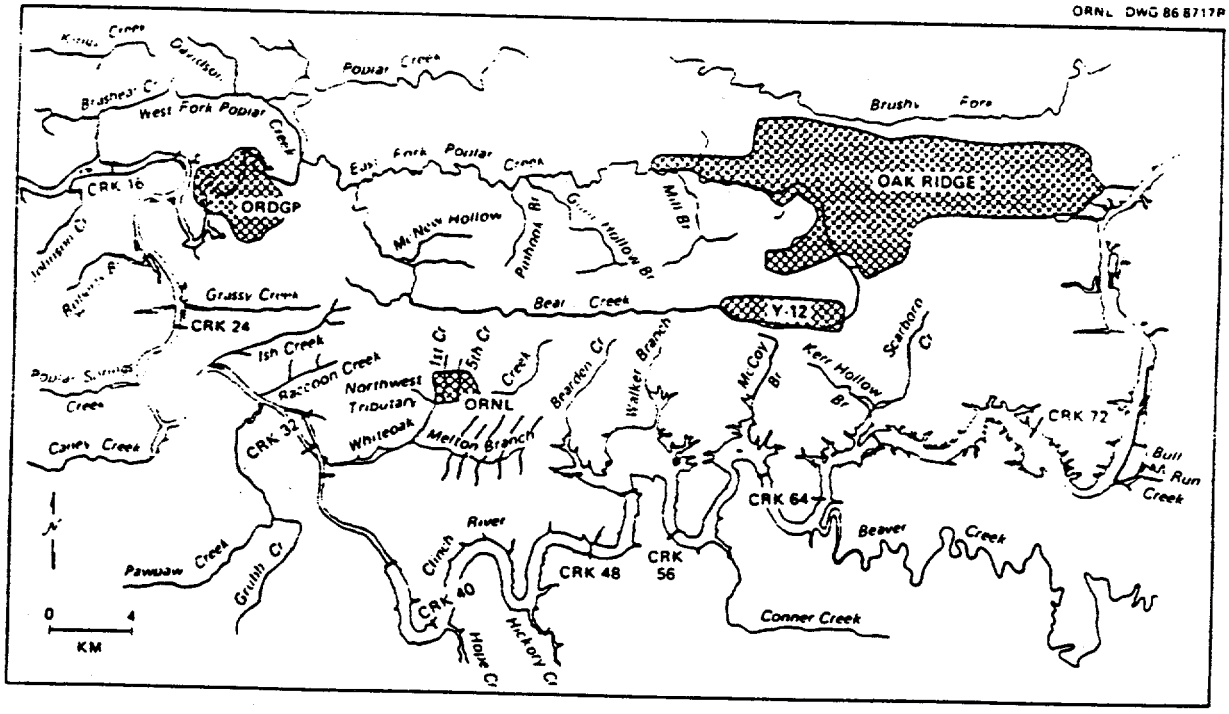


Fig. 7. The Clinch River and its tributaries on the ORR.

formed in 1943. The base-flow discharges of White Oak Creek are low, and, at times in the late fall, periods of no natural flow have been observed. Discharges from ORNL substantially augment the dry weather flow of White Oak Creek.

The Y-12 Plant discharges wastewater into both Bear Creek and East Fork Poplar Creek. The 19,200-km^2 (7.4-mile^2) drainage basin of Bear Creek begins at the southwestern boundary of the Y-12 Plant. The creek meanders westward through Bear Creek Valley and then flows northwest to join East Fork Poplar Creek. Its flow rate ranges from 0.01 to 17 m^3/s (0.35 to 600 ft^3/s) at Bear Creek km 1.29 (mile 0.8).[1] The headwaters of East Fork Poplar Creek originate on the northwestern slopes of Chestnut Ridge in the vicinity of the Y-12 Plant. The creek is contained in culverts through about half of the plant area before it emerges in a rip-rapped ditch approximately 2.4 m high by 2-6 m wide (8 ft high by 10-15 ft wide). Y-12 discharges contribute to the majority of the stream flow of East Fork Poplar Creek. The flow rate of East Fork Poplar Creek ranges from 0.37 to 74 m^3/s (13 to 2609 ft^3/s) at East Fork Poplar Creek km 5.31 (mile 3.3).[1] Stream flow is presently controlled by New Hope Pond, an approximately 2-ha (5-acre) pond on the east end of the plant that serves as a settling basin. East Fork Poplar Creek flows through the City of Oak Ridge, where it receives discharges from the Oak Ridge sewage treatment plant, industrial discharges, and area runoff before discharging into Poplar Creek.

Poplar Creek is the largest stream flowing into the Clinch River from the ORR with a flow rate ranging from 0.14 to 180 m^3/s (5.0 to 6356 ft^3/s) at the mouth of Poplar Creek. It has a drainage area encompassing 350,000 km^2 (136 mile^2).[1] The headwaters of Poplar Creek originate outside the ORR and are adversely affected in many areas because of acid mine drainage. Domestic sewage from several small communities in the upper Poplar Creek basin is discharged into the stream. Poplar Creek, upon entering the ORR, is characteristically turbid and has high concentrations of dissolved and suspended solids. East Fork Poplar Creek is a major source of pollutants entering Poplar Creek.

The groundwater on the ORR flows from areas of high elevation to areas of low elevation and ultimately discharges into the surface streams. Groundwater discharge contributes to the base flow of surface streams that ultimately augment the Clinch River water supply. Thus, the base flow of the Clinch is determined by groundwater discharges to the surface water system. It is unlikely that significant groundwater flow could pass beneath the Clinch. Details of ORR hydrology can be found in Ref. 1.

3. ORR WATER BALANCE

There are 10 public water supply systems serving about 91,500 people that withdraw surface water within a 32-km (20-mile) radius of the ORR, as listed in Table 1. Of these supply systems, only one is downstream of the ORR outfall. The intake for Kingston is located at Tennessee River kilometer 914.2 (TRM 568.2), about 0.6 km (0.4 mile) above the confluence of the Clinch and Tennessee rivers

Table 1. Public supply surface water withdrawals within about 32 km of the ORR[a]

Public supply system	Population served (thousand)	Average withdrawal rate (m^3/s)	Withdrawal source and location	Distance from ORR (km)
Clinton	6.2	0.03	CRK 106.7	25.1
Harriman	10.0	0.10	ERK[b] 20.8	21.7
Kingston	5.0	0.014[c]	TRK 914.2	20.9
Lenoir City	6.6	0.04	TRK 967.5	16.6
Loudon	5.2	0.03[d]	TRK 953.0	21.7
Anderson County Utility Board	8	0.03	CRK 89.3	14.5
Cumberland Utility District of Roane and Morgan counties	4.3	0.008[e]	LEREK[f] 3.5	14.0
First Utility District of Knox County	10.5	0.05	SCEK[g] 2.7	18.7
Hallsdale-Powell Utility District	28.7	0.07[h]	BRCEK[i] 2.1	18.2
West Knox County Utility District	15.0	0.06[j]	CRK 74.2	16.3

[a]Source: Ref. 28.
[b]ERK = Emory River kilometer.
[c]Secondary source (9%); spring (91%).
[d]Half source (50%); spring (50%).
[e]Secondary source (5%); spring (95%).
[f]LEREK = Little Emory River Embayment kilometer.
[g]SCEK = Sinking Creek Embayment kilometer (Tennessee River).
[h]Primary source (70%); spring (30%) (outside 25-km radius).
[i]BRCEK = Bull Run Creek Embayment kilometer (Clinch River).
[j]Primary source (90%); well (10%).

and 34.1 km (21.2 miles) below the ORR outfall. As indicated in Table 1, Kingston withdraws approximately 9% of its average daily supply from the Tennessee River. The city of Rockwood withdraws about 1% of its average daily supply from Watts Bar Reservoir. Its intake is located 2 km (1.3 miles) from the mouth of King Creek embayment near TRK 890 (TRM 553). Industrial water withdrawals from the Clinch-Tennessee system surrounding the ORR are listed in Table 2.

3.1 OAK RIDGE RESERVATION

3.1.1 ORR Raw and Treated Water Supply

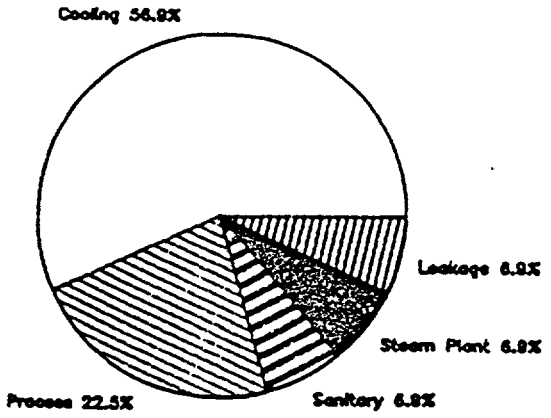
The ORR facilities receive water from the DOE treatment plant, the ORGDP treatment plant, and raw water pump stations. Treated water usage for Y-12, ORNL, and ORGDP is shown in Fig. 8. Periodic low volume rates are taken from Melton Hill Lake and groundwater wells.

The DOE treatment plant has the capacity to treat 106 million liters (28 million gallons) of raw water a day, but currently treats only 58.6 million liters (15.5 million gallons). It is located at the Clinch River kilometer 66.8 and is operated by Rust Engineering for DOE. The DOE plant supplies treated water to the Y-12 Plant including Rust operations, ORNL, the city of Oak Ridge, the Industrial park off Bear Creek Road, and the Scarboro Facilitty operated by ORAU. 43% of the treated water at the DOE plant is used by Y-12, 28% is used by

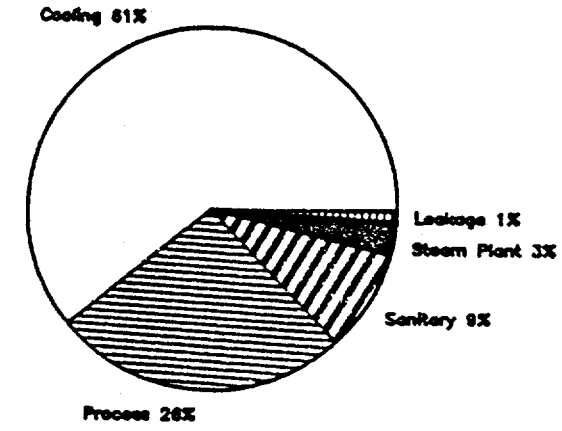
Table 2. Industrial water withdrawals from the Clinch-Tennessee River system[a]

Industrial water user	Average withdrawal rate (m^3/s)	Withdrawal source and location		River distance from mouth of White Oak Creek (km)
Withdrawals above White Oak Creek (mouth of CRK 33.5)				
Modine Manufacturing Co.	0.05	CRK	103.7	71.2
Tennessee Valley Authority Bull Run Steam Plant	25	CRK	77.2	43.7
U.S. Department of Energy ORNL, Y-12, Scarboro Facility, and City of Oak Ridge	0.96[b]	CRK	66.8	33.3
Withdrawals below White Oak Creek				
ORGDP	0.13[b]	CRK	23.3	10.2
ORGDP	0.54[c]	CRK	18.5	15.0
Tennessee Valley Authority Kingston Steam Plant	61.3	ERK	2.9	29.6
Watts Bar hydro plant, lock, and steam plant	0.02	TRK	851.5	94.5

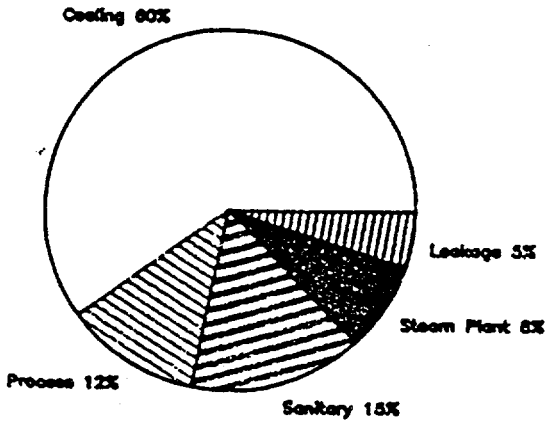
[a]Source: Ref. 28.
[b]Process and potable water.
[c]Cooling water makeup only.



ORNL Total Usage: 16.4 MLPD (4.3 MGPD)



Y-12 Total Usage: 25.0 MLPD (6.6 MGPD)



ORGDP Total Usage: 8.1 MLPD (2.13 MGPD)

Fig. 8. Treated water usage--Y-12 Plant, ORNL, and ORGDP.

ORNL, and 29% by Oak Ridge. Of the Oak Ridge usage, 98.7% is used by the city of Oak Ridge (17.5 million liters (4.5 million gallons) per day. 3% by the Industrial park (64,000 liters (17,000 gallons) per day, and 1% by the Scarboro facility (163,000 liters (43,000 gallons) per day.

The ORGDP treatment plant has a capacity of 30.28 million liters (8 million gallons) per day and currently treats 8 million liters (2.13 million gallons). It is located on Clinch River kilometer 23.3. Treated water is supplied to ORGDP.

Raw water is pumped from Clinch River kilometer 66.8 to the Y-12 Plant and from Clinch River kilometer 18.5 to ORGDP. The Y-12 Plant uses approximately 9.1 million liters (2.4 million gallons) per day and ORGDP uses 2.3 million liters (0.6 million gallons) per day. Well water was used for aquatic experiments in the Environmental Sciences Division from 1972-1983 at a rate of (378-757 liters (100-200 gallons) per minute. Future uses for the aquatic lab are expected to be 946 liters (250 gallons) per minute.

The Clark Center Recreation Area uses water from Melton Hill Lake. The recreation center has a small package treatment unit to filter the water for sanitary purposes. Treated water is available to the facilities from the middle of April through the end of October; usage averages 151 liters (40 gallons) per day. Water from the drinking fountains is discharged back to Melton Hill Lake. The sanitary sewage is collected in a holding tank whose contents are collected by a private contractor and hauled to a sewage treatment plant selected by the contractor.

3.1.2 ORR Discharges

Surface water discharges either directly or indirectly to the Clinch River total

67.25 million liters (17.74 million gallons) per day. This includes 10.5 million liters (2.8 million gallons) per day from ORNL to White Oak Creek, 29.5 million liters (7.8 million gallons) per day from the Y-12 Plant to East Fork Poplar Creek, 2.3 million liters (0.6 million gallons) per day from the Y-12 Plant to the Oak Ridge sewage treatment plant, 7.49 million liters (1.97 million gallons) per day from ORGDP to the Clinch River, and 17.4 million liters (4.6 million gallons) per day from the City of Oak Ridge, the Industrial Park, and the Scarboro Facility to the Oak Ridge sewage treatment plant. The Energy Systems facilities on the ORR discharges include cooling water, process water, sanitary water, steam plant wastewater, and leakages.

3.2 Y-12 PLANT SITE

3.2.1 Y-12 Plant Water Use

Figure 9 summarizes the water balance at the Y-12 Plant site.

The Y-12 Plant has separate piping systems for raw and treated water. Raw water, used for ash sluicing at the steam plant, is routed to the Y-12 Plant by two lines, one from the booster station and one from the filtration plant. The average raw water usage at the Y-12 Plant is approximately 9 million liters (2.4 million gallons) per day.

Treated water is routed from the DOE filtration plant to the Y-12 Plant by three lines. The treated water system supplies the cooling systems, fire protection system, process operations, sanitary requirements, and boiler feed at the steam plant. The average treated water usage for the Y-12 Plant is approximately 22–27 million liters (6–7 million gallons) per day. The major water users at the Y-12 Plant are listed in Table 3.

3.2.2 Y-12 Plant Water Discharges

Discharges from the Y-12 Plant area affect water quality and flow in Kerr Hollow Quarry, Rogers Quarry, East Fork Poplar Creek, or Bear Creek before entering the Clinch River. Regulators have directed the Y-12 Plant to stop the direct discharge of unpermitted liquid wastes to East Fork Poplar Creek and to the S-3 ponds. Until the new wastewater treatment facilities are constructed and ready for operation, much of Y-12's wastewater is being transported to ORGDP for treatment. Discharges from the Y-12 Plant include sanitary and process wastewaters, coal yard runoff and ash sluice, storm drainage, cooling water, and cooling tower blowdown. Process wastewaters include effluents from pollution control treatment facilities, photographic laboratories, firefighter training areas, plating operations, plant laboratories, and chemical preparation and makeup areas. Major point discharges and treatment facility discharges are categorized according to their NPDES outfalls in Table 4.[2]

The sanitary sewage effluent from the Y-12 Plant site flows to the City of Oak Ridge West End Treatment Plant. The average daily flow is approximately 2 to 2.7 million liters (500,000 to 700,000 gallons) per day and is independent of storm drainage and industrial waste systems.[3]

A network of storm drains covers the entire area of the Y-12 Plant that discharges into East Fork Poplar Creek. The system gathers rainfall from the adjacent hillsides, the parking areas north of the developed portion of the plant, the roof drains, and fire water flow from the testing of the fire protection system. Also interconnecting with the storm drainage system are numerous process discharges and laboratory drains within the buildings, building floor

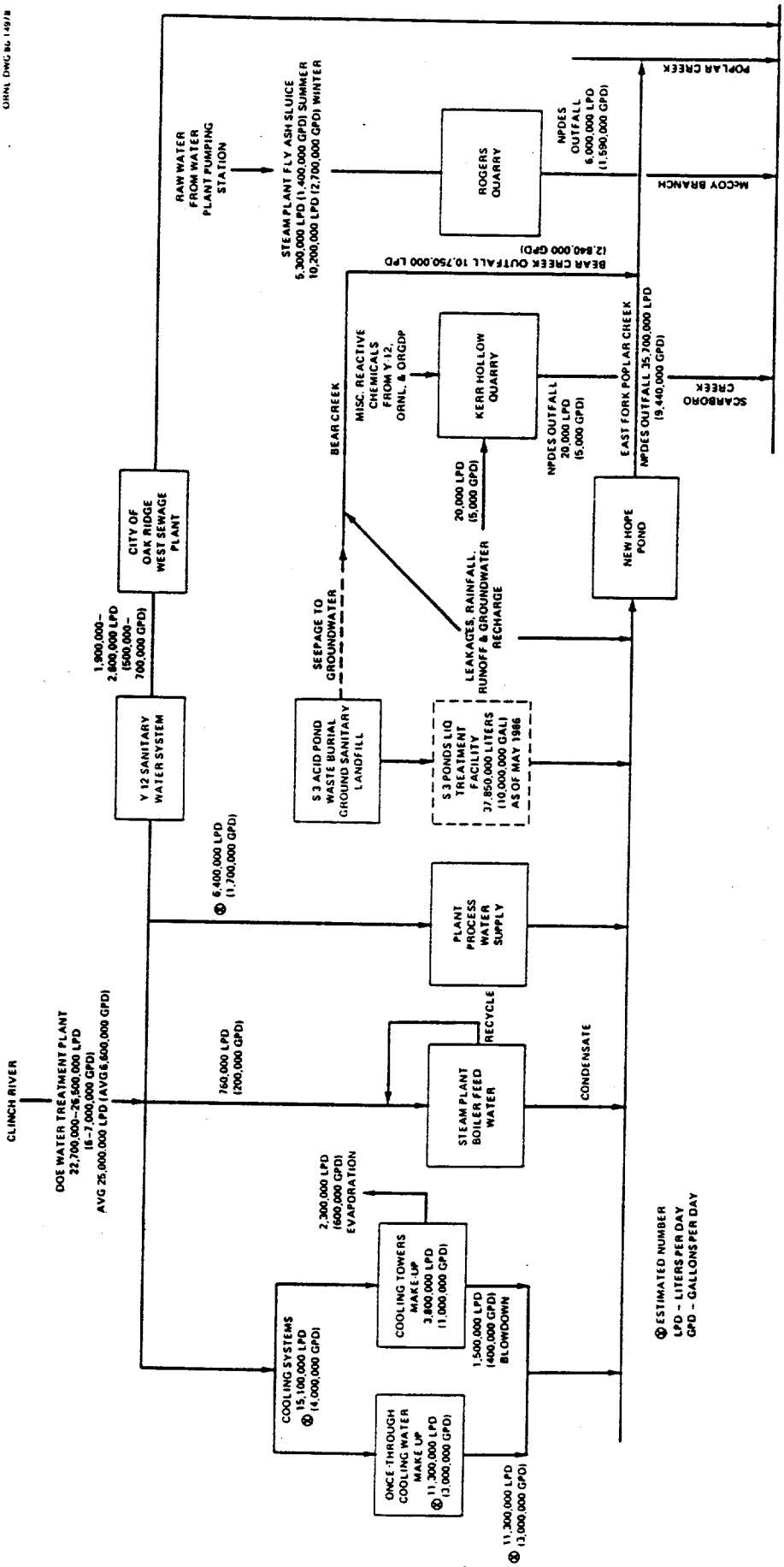


Fig. 9. Y-12 Plant water supply and discharge.

Table 3. Major water users at the Y-12 Plant[a]

Users	Volume[b] (L/d)		Total usage (%)
Cooling systems (cooling tower and once-through cooling water makeup)	15,100,000	(4,000,000)	61
Process systems	6,400,000	(1,700,000)	26
Sanitary water	2,300,000	(600,000)	9
Steam plant	760,000	(200,000)	3
Leakage	400,000	(100,000)	1
Total	22–26,500,000	(6–7,000,000)	
Average total	25,000,000	(6,600,000)	
Raw water usage, steam plant fly ash sluice, and boiler cleaning	9,100,000	(2,400,000)	

[a]Total water usage at the steam plant is metered; water use for the cooling towers is calculated; sanitary water usage is estimated from the amount treated at the sewage plant; cooling water, process water, and leakage are estimated.

[b]Gallons per day are shown in parentheses.

drains, drains from accumulation tanks outside the buildings, and sump pump outlets that gather the seepages of groundwater at basement levels. Efforts to improve the water quality of streams receiving Y-12 discharges are ongoing. The NPDES permit has been established using best available technology as a basis for discharge. Environmental monitoring stations are planned to characterize area source contamination.

There are 21 major cooling tower systems and 6 small air conditioning towers in operation at the Y-12 Plant. Approximately 1380 million liters (360 million gallons) per year are required as makeup for the 21 major cooling tower systems. About 550 million liters (146 million gallons) per year are discharged as blowdown into East Fork Poplar Creek, and 830 million liters (219 million gallons) are lost as evaporation. The blowdown consists of hard water containing nontoxic chemical treatment (a corrosion inhibitor and a microbiocide). The cooling tower system is being upgraded by replacement of old and leaky towers and a change in the chemical treatment to meet NPDES permit requirements. These changes are helping to reduce the total amount of water consumption.

3.3 ORNL SITE

3.3.1 ORNL Water Use

Figure 10 summarizes the water balance of the ORNL plant site.

Table 4. Y-12 Plant NPDES discharges

Serial # discharge	Effluent discharges	Average flow[a] ($L \times 10^6$/d)		Receiving stream
	Point discharges			
301	Kerr Hollow Quarry (disposal of reactive metals)	0–0.02	(0–0.005)	Scarboro Creek to Clinch River
302	Rogers Quarry (fly ash sluice water & nonreactive metal parts disposal)	1.70–7.57	(0.45–2.0)	McCoy Branch to Clinch River
303	New Hope Pond (treated industrial wastewater, cooling tower blowdown, once-through cooling water, storm and surface runoff)	30.28	(8.0)	EFPC
304	Bear Creek (surface runoff)	15.90	(4.2)	Bear Creek
305	Oil pond #1 (leaking burial ground and wet weather springs)	0.05	(0.014)	Bear Creek
306	Oil pond #2 (seepage from burial pit and surface water runoff)	Infrequent		Bear Creek

Serial # discharge	Treatment facility	Average flow[b] ($L \times 10^6$/year)		Receiving stream
	Treatment facility discharges			
501	Central Pollution Control Facility (CPCF-I)	3.79	(1.0)	EFPC
502	Central Pollution Control Facility Phase II (CPCF-II) (until WETF comes on line)	9.46	(2.5)	EFPC
503	Steam plant wastewater treatment facility	178.0	(47.0)	EFPC
504	Plating rinse water treatment facility (PRWTF)	30.28	(8.0)	EFPC
505	ORNL Biology Division wastewater treatment facility	299.0	(79.0)	EFPC
506	Sump pump oil separator (9204-3)	5.68	(1.5)	EFPC
507	S-3 ponds liquid treatment facility	37.85	(10.0) (as of 5/86)	
508	Experimental mobile wastewater treatment facility	98.42	(26.0)	EFPC
510	Waste coolant processing facility	0.76	(0.20)	EFPC

[a]Flow in millions of gallons per day is given in parentheses.
[b]Flow in millions of gallons per year is given in parentheses.

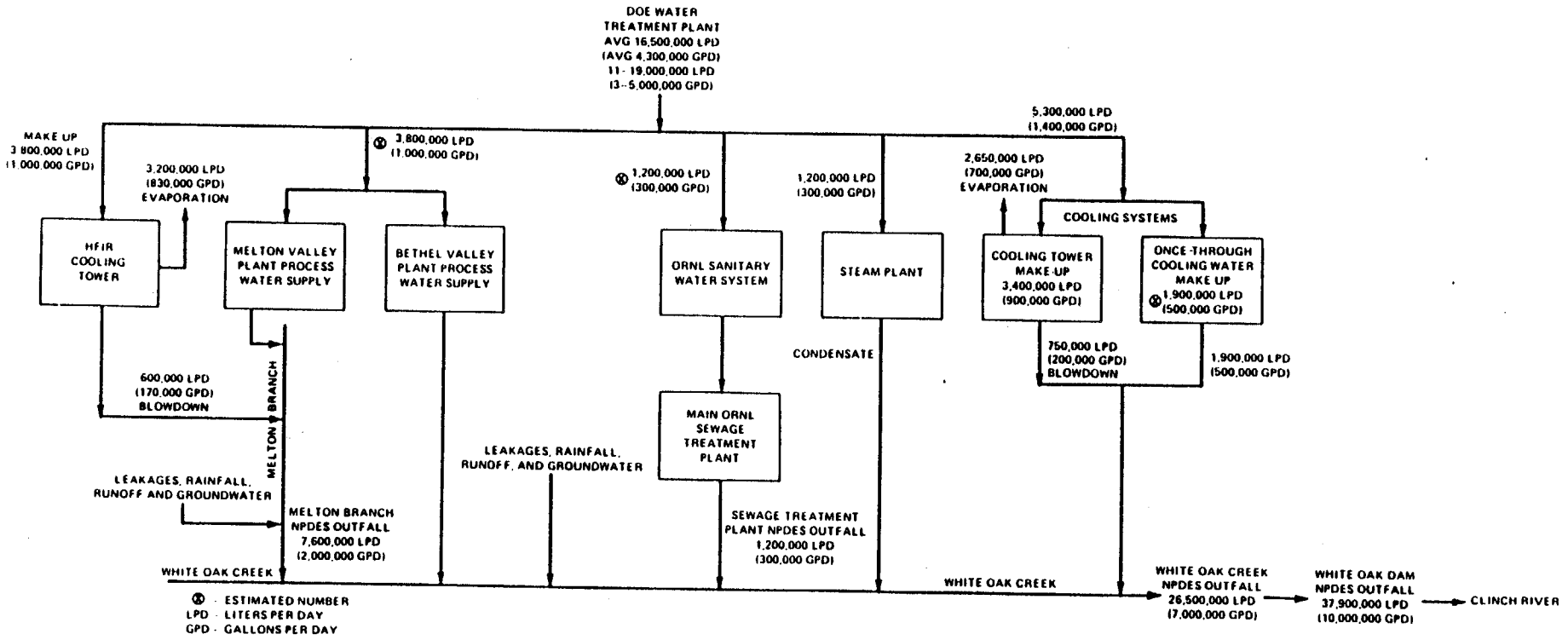


Fig. 10. ORNL water supply and discharge.

Water is supplied to the ORNL plant site through a single main line from the DOE water treatment plant. An 11-million-liter (3-million-gallon) storage tank is located on the south slope of Chestnut Ridge near the Bethel Valley site. Two 5.7-million-liter (1.5-million-gallon) tanks are also located on Haw Ridge. Water is distributed to ORNL facilities through two separate systems: potable and process. Process water has the potential for becoming contaminated and therefore unfit for human consumption. The potable water system supplies the process system and is protected from back contamination by reduced-pressure backflow-preventer valves. Cooling water is obtained from the process water system. Treated water usage at ORNL varies from approximately 11 to 19 million liters (3 to 5 million gallons) per day;[4,5] the major water users at ORNL are summarized in Table 5.

Several improvements could be implemented to upgrade the potable and process water systems at ORNL. Because there are no flow meters at the points of usage or at the locations where the process water lines tie into the potable water system, there is a lack of accurate flow data. Several improvements have been identified that would provide needed reliability for fire protection at or near the points of use on the process system, and appropriate projects have been proposed. The fact that ORNL is supplied water through a single line makes the Laboratory vulnerable to outages. This lack of a backup supply line is the major deficiency in the water system at ORNL.

3.3.2 ORNL Water Discharges

All discharges from ORNL are received by the White Oak Creek drainage basin. Discharges include sanitary wastewaters,

Table 5. Major water users at ORNL[a]

Users	Volume[b] (L/d)		Total usage (%)
Cooling systems (cooling tower and once-through cooling water makeup)	9,000,000	(2,400,000)	56
Process systems	3,800,000	(1,000,000)	23
Sanitary water	1,200,000	(300,000)	7
Steam plant	1,200,000	(300,000)	7
Leakage	1,200,000	(300,000)	7
Total	11–19,000,000	(3–5,000,000)	
Average Total	16,400,000	(4,300,000)	

[a]Total water usage at the steam plant is metered; water use for the cooling tower is calculated; sanitary water is estimated from the amount treated at the sewage treatment plant; cooling water, process water, and leakage are estimated.

[b]Gallons per day are shown in parentheses.

coal yard runoff and ash washwater, storm drainage, process wastewaters, cooling water, and cooling tower blowdown. Process wastewaters are generated by operation of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities. The discharges are categorized according to their NPDES outfalls in Table 6.[6]

The ORNL sewage system includes the main system, the 7900 area system, and

Table 6. ORNL NPDES discharges

Serial # discharge	Effluent discharges	Flow[a] ($L \times 10^6$/d)			Receiving stream
X01	Sewage treatment plant	Av	0.87	(0.23)	WOC
		Max	2.84	0.75	
X02	Coal yard runoff treatment facility	Av	0.09	(0.024)	WOC
		Max	0.83	(0.22)	
X03[b]	1500 area	Av	0.028	(0.0058)	Northwest tributary of WOC
X04[b]	2000 area	Av	0.05	(0.014)	WOC
X06[b]	3539 and 3540 ponds	Av	0.51	(0.135)	WOC
X06A[c]	X03, X04, X06, X07	Av	0.98	(0.26)	NRWTP to WOC
X07[b]	3544 Process Waste Treament Plant	Av	0.68	(0.18)	WOC
		Max	1.63	(0.43)	
X08[b]	TRU process waste basin	Av	0.19	(0.05)	Melton Branch
X09[b]	HFIR process waste basin	Av	0.61	(0.16)	Melton Branch
X09[c]	X08, X09	Av	0.79	(0.21)	NRWTP to WOC
X10	ORR resin regeneration (as part of NRWTP)	Av	0.03	(0.0085)	Fifth Creek (vendor contract)
			0	(0)	
X11	3518 acid neutralization (in the future)	Av	0.15	(0.04)	WOC (NRWTP or CYRTF)
X12	Nonradiological Wastewater Treatment Project	Av	1.89	(0.5)	WOC (vendor contract)
		Max	3.03	(0.8)	
X13	Melton Branch X08, X09, HFIR cooling tower blowdown, and area runoff	Av	7.57	(2.0)	Melton Branch to WOC
X14	WOC and area runoff	Av	26.50	(7.0)	White Oak Lake
X15	White Oak Lake Dam and WOC drainage basin	Av	37.90	(10.0)	Clinch River

[a]Flow in millions of gallons per day is given in parentheses.
[b]Proposed piping changes to X06A or X09A outfalls.
[c]Discharges to NRWTP upon completion.

other minor systems. The main ORNL sewage treatment plant, which discharges treated effluent to White Oak Creek at an average flow of approximately 1.1 million liters (300,000 gallons) per day, had been unable to provide adequate treatment of sanitary waste because of design limitations and periodic hydraulic overloading resulting from excessive inflow and groundwater infiltration. A sewer system evaluation survey, completed in 1980, found that approximately 190,000 liters (50,000 gallons) per day of infiltration were entering the sewer system through defective line sections. To reduce the inflow and infiltration problem, selected sanitary sewer pipes have been lined by a process called Insituform. A new, extended aeration-activated sludge plant became operational in August 1985.

Storm water has been identified as a major transporter of contaminants from the ORNL site. Sampling programs for characterization of contaminants in storm water are being initiated. Storm water runoff is either collected by a formal system of catch basins and constructed waterways or carried by natural drainage ways. A preliminary evaluation revealed that in many cases storm drainage from an entire area of ORNL empties into one or two major drainage pipes before it is discharged into streams. Capital projects have been implemented to segregate contaminated process wastewater from the storm drain system.

In the past, effluent from the process waste (PW) treatment system was discharged into White Oak Creek. Changes to the PW system are required to ensure compliance with regulations imposed by the Clean Water Act (CWA) and DOE Order 5480.1. The Nonradiological Waste Treatment Plant (NRWTP) will provide the treatment needed to obtain compliance.

The NRWTP will treat all nonradiological wastes, including heavy metals and organics, previously discharged into White Oak Creek. Tankage will be provided as part of the NRWTP to replace ponds that have the potential of leaking and contaminating groundwater and surface water. The NRWTP will provide additional treatment of ORNL process wastewaters, which should improve the water quality of White Oak Creek.

There are 26 cooling towers at ORNL that discharge to area streams and storm sewers. Approximately 16% [7.2 million liters (1,900,080 gallons) per day] of the total makeup water for all the cooling towers is lost as blowdown, 7% [500,000 liters (130,000 gallons) per day] is lost as drift, and 77% [5.7 million liters (1,500,000 gallons) per day] is lost to the atmosphere as evaporation. Effluent from these towers contains chemicals to retard algae growth that can be toxic to marine and aquatic life. Plans are being developed to characterize the extent and impact of the effluents and to determine appropriate corrective action.

3.4 ORGDP SITE

3.4.1 ORGDP Water Use

Figures 11 and 12 summarize the water balance at the ORGDP site.

The average daily use of water at ORGDP before the plant was placed in a standby mode was approximately 15 million liters (4 million gallons) per day. At present, it is approximately 8 million liters (2.13 million gallons) per day. Potable water is used primarily for sanitary and process purposes. Processes requiring potable water include production of steam, preparation of metal treatment and cleaning solutions, chemical process-

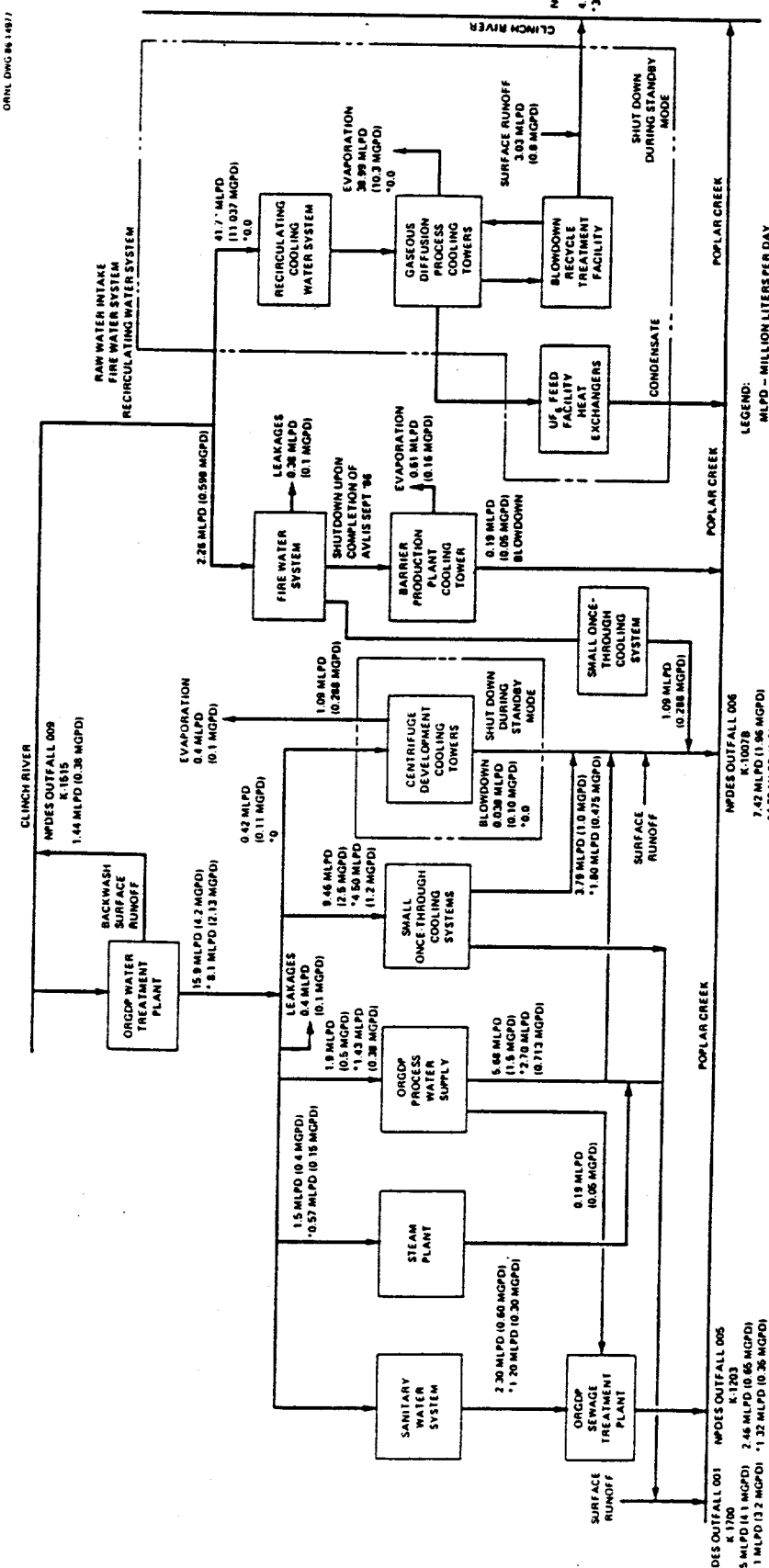


Fig. 11. ORGDP water supply and discharge.

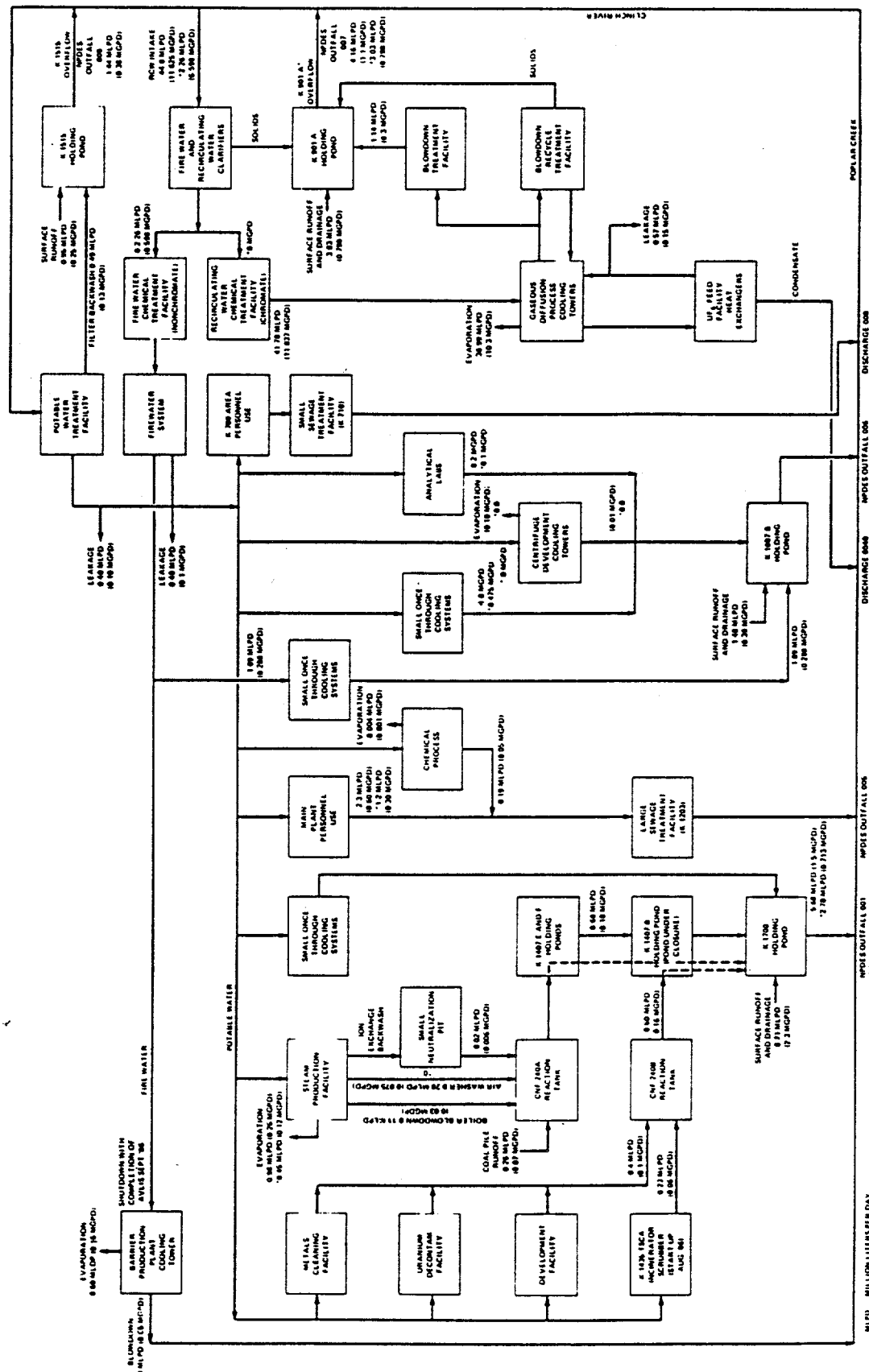


Fig. 12. Detailed ORGDP water supply and discharge.

ing, laboratory use, laundry purposes, and once-through cooling.

The raw water makeup supply for the recirculating cooling water (RCW) system can be taken from the Clinch River pumping station or Poplar Creek, but it is usually taken from the Clinch because its water quality is better. Makeup water is required for the RCW system to replace the water lost by evaporation and blowdown. The fire protection water system is supplied by the nonchromated, but softened and treated, water loop of the RCW system. Total raw water used before ORGDP was put in standby mode was 44 million liters (11.6 million gallons) per day. At present, raw water is required only for the fire water system, at a rate of 2.3 million liters (0.6 million gallons) per day because the RCW system has been shut down.[3,7] The major ORGDP water users are listed Table 7.

3.4.2 ORGDP Water Discharges

The NPDES permit for ORGDP has six authorized discharge points. Samples are collected at five of the six outfalls and at

Table 7. Major water users at ORGDP[a]

	Full-scale operation			Standby mode		
	Volume[b] ($L \times 10^6$/d)		Total (%)	Volume[b] ($L \times 10^6$/d)		Total (%)
ORGDP potable water treatment facility						
Cooling systems (including small once-through systems)	9,800,000	(2,600,000)	62	4,500,000	(1,200,000)	60
Sanitary water	2,300,000	(600,000)	14	1,200,000	(300,000)	15
Process water	1,900,000	(500,000)	12	1,430,000	(380,000)	12
Steam plant	1,500,000	(400,000)	10	570,000	(150,000)	8
Leakage	400,000	(100,000)	2	400,000	(100,000)	5
Total	15,900,000	(4,200,000)		8,100,000	(2,130,000)	
Raw water						
RCW system	41,600,000	(11,000,000)	95			
Fire water system	2,300,000	(600,000)	5	2,300,000 1,500,000	(600,000) (400,000)[c]	100
Total	43,900,000	(11,600,000)		2,300,000 1,500,000	(600,000) (400,000)[c]	

[a]Total water usage and water at the steam plant is metered; water for the cooling towers is calculated; sanitary water is estimated from amount treated at the sewage plant; the remainder of cooling water, process systems water, and leakage are estimated.

[b]Water usage in millions of gallons per day is given in parentheses.

[c]Upon completion of AVLIS.

three internal wastewater discharges. The sixth outfall has been shut down because of insufficient loading and therefore is not monitored. All process water discharges from the plant pass through an NPDES monitoring point. However, many storm drains, some with noncontact cooling water discharges, are not monitored at an NPDES sampling point. Since ORGDP has been in standby mode the major liquid discharge decreases have been the elimination of blowdown from the RCW system and the centrifuge development cooling towers and a decrease in sewage effluent. The discharges are categorized according to their NPDES outfalls in Table 8.[8]

The ORGDP operates two sanitary sewage systems. The main site has an extended aeration treatment plant with a rated capacity of 2.3 million liters (600,000 gallons) per day and a current use of approximately 1.1 million liters (300,000 gallons) per day. Improvements have been made to the collection lines to reduce inflow and infiltration. During periods of heavy rain, raw sewage is partially diverted into a 1-million-liter (270,000-gallon) tank to reduce the heavy loading on the treatment facility. Treated effluent from the main plant is discharged into Poplar Creek.[7]

Because of their remoteness and low volume of use, outlying facilities such as the power house area, rifle range, and water treatment plant use septic tanks with drain fields. The power house area has a packaged treatment plant with a rated capacity of 76,000 liters (20,000 gallons) per day that is not now in use.[7]

Surface runoff within the ORGDP site is drained by Poplar Creek to the Clinch River. Improvements to the surface runoff system include drainage channeled by swales, where appropriate, rather than by piped drain systems. This technique is used to moderate stream flows by enhancing percolation to groundwater systems and reducing runoff quantity and rate. A storm sewer survey is being undertaken to determine flow rates.

The ORGDP was the only ORR facility that recycled its cooling tower blowdown. Because the plant has been placed in standby operation, the treatment facility of the RCW system is no longer used. When in operation, of the 42 million liters (11 million gallons) per day to the RCW system, 39 million liters (10.3 million gallons) per day were lost due to evaporation. The blowdown, 2.7 million liters (0.7 million gallons) per day, was treated and recycled. This system is elaborated on in Ref. 9. Small once-through cooling systems are now in operation and only one cooling tower, the barrier production plant cooling tower, is currently operated (but is scheduled for shutdown). The cooling tower requires 800,000 liters (0.21 million gallons) per day of makeup water; 600,000 liters (0.16 million gallons) per day are evaporated to the atmosphere, and 200,000 liters (0.05 million gallons) per day are discharged as blowdown.

Table 8. ORGDP NPDES permit discharges

Serial discharges	Effluent discharges	Average flow[a] ($L \times 10^6$/d)		Receiving stream
		Full-scale operation	Standby mode	
K-1700	Steam plant and coal yard Metals cleaning facility Uranium recovery Chemical Process Development Facility Y-12 treated wastewaters Surface runoff	15.5 (4.1)	12.1 (3.2)	
K-901-A	Treated blowdown from plant RCW system (deleted due to standby operation) Lime softening sludges from RCW makeup treatment (deleted due to standby operation) Surface runoff	4.16 (1.1)	3.03 (0.8)	Clinch River
K-1203	Sanitary wastewaters Y-12 treated wastewaters Organic industrial wastewaters Surface runoff	2.46 (0.65)	1.32 (0.35)	Poplar Creek
K-1007-B	Potable water from once-through cooling systems Fire water from once-through systems Surface runoff	7.42 (1.96)	4.73 (1.25)	Poplar Creek
K-1515	Water from sludge and backwash systems associated with the potable water plant Surface runoff	1.44 (0.38)	1.44 (0.38)	Clinch River

[a]Flow in millions of gallons per day is given in parentheses.

4. WATER CONSERVATION PLAN

4.1 WATER USAGE

Although water scarcity has not been a problem for the facilities on the ORR, maximizing the efficiency of water usage is part of the water conservation plan; several options are available.

About 1 to 7% of the treated water supply at each plant is lost through leakages in the process and potable water lines. These systems will be upgraded in proposed utilities projects, which should result in minimizing water losses.

The potential for recycle as a means of minimizing water use has been studied by the ORR facilities. The concept of recycling effluent streams stems from the national goal, proposed by the CWA, that discharges into waterways be eliminated. A study was performed on recycling the NRWTP treated wastewaters.[10] The major conclusions of this initial study were that additional treatment processes would be required and that quality assurance concerns would have to be addressed to guarantee minimum water quality for many process and potable uses. A committee was established at the Y-12 Plant to evaluate options available for recycling water from treatment processes and cooling water. To recycle effluent from treatment facilities to be used as makeup water for cooling towers and once-through cooling systems would require additional treatment processes; e.g., recycling cooling tower blowdown as makeup water would require softening treatment facilities. Although the major consumption of water at the ORR facilities—over 50% of total treated water usage—is for the cooling systems, the need for additional treatment facilities does not make recycle an attractive economic alternative at this time.

Precise accountability of water use on the ORR is not possible because of the lack of flow meters at the points of usage. Records are maintained only at the water treatment plants to indicate plant-wide usage, at the cooling towers, and at the steam plants. The differentiation of the remaining water used at the plants, such as the distinction between once-through cooling water, water used for the various processes, and sanitary water, can only be estimated. Installation of flow meters for accountability of water usage on the ORR would help identify points where it could be minimized.

4.2 WATER QUALITY IMPROVEMENTS

4.2.1 Regulations

Pollution control and water quality preservation are the responsibility of DOE for the ORR facilities as required by state and federal acts, regulations, and standards. These include DOE Order 4300.1A—the Water Conservation Plan; DOE Order 5480.4—Environmental Protection, Safety, and Health Protection Standards; Resource Conservation and Recovery Act (RCRA); Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA); Safe Drinking Water Act; CWA; Toxic Substance Control Act; and National Environmental Policy Act. The major goals of these regulations are to protect public health and the environment and to conserve resources directly and through management, reuse, and recovery. In general, these regulations specify the limits for allowable concentrations for all identified pollutants and require detailed characterizations, quantifications, and reporting of pollutants and hazardous materials.[11]

The impacts of the ORR facilities' effluent discharges can be minimized and/or mitigated by appropriate wastewater treatment and disposal. Several plans associated with regulatory compliance have been prepared by the ORR facilities which are a part of this water conservation plan. These include best available technology; best management practices; toxic control monitoring; biological monitoring and abatement; radiological monitoring; PCB monitoring; mercury assessment; and spill prevention control, countermeasures, and contingency plans. Each major facility has published a long-range environmental plan. Documents have been prepared that address specific issues of water quality protection practices on the ORR. Policies on minimized wastes, cost control, and the as-low-as-reasonably-achieveable (ALARA) philosophy are being developed. In addition, the NPDES permit program has been based on best available treatment technology to preserve and improve the water quality of receiving streams within the ORR.

4.2.2 Waste Management Strategies

Past waste management activities on the ORR have had an impact on the surrounding environment, resulting in some contamination of soil, groundwater, surface water, and sediments. Each of the three Energy Systems facilities has developed extensive programs for air and water pollution control and solid waste management. Each program involves planning, characterization, and capital project implementation. Policy guidelines being developed for the ORR waste management strategy also serve as guidelines for protection of water quality. An overall Energy Systems policy for minimizing waste is being developed to reduce the release of potential pollutants. Reduction of waste generation rates and volumes, avoidance of land disposal of RCRA hazardous wastes, and termination of the acceptance of non-ORO contractors' or subcontractors' wastes will lead to the reduction of pollutant loading in groundwater and surface water. Fixed/stabilized wastes must pass rigorous leachability tests to ensure that their disposal will not contaminate surface water or groundwater.

Waste streams must be completely characterized to determine appropriate treatment, storage, or disposal methods. Waste management and disposal must comply with the appropriate DOE, state, and federal regulatory requirements including applicable codes and standards pertaining to health, safety, and fire protection. Waste characterization, treatment, disposal, and environmental impacts are described in detail in Ref. 5. Plans for implementing projects to reduce environmental impacts of waste management activities are outlined in Refs. 8, 12, and 13.

4.2.3 Remedial Action

Remedial action programs are needed to protect water quality on the ORR.

Facilities that contain radioactive and/or hazardous materials include burial grounds, storage facilities, surface impoundments, tanks, ponds, process lines, and waste sites. Point and nonpoint liquid effluents from the ORR facilities include runoff from coal storage piles; potential runoff and leachate from sanitary landfills; and runoff, leachates, and seepage of liquids stored in the burial grounds. Past operational activities have caused water pollution problems that will continue unless remedial actions are undertaken.

Remedial action programs are being developed and implemented to meet RCRA and CERCLA requirements. The remedial action decision analysis involves three phases: assessment, characterization, and final verification that the remedial actions comply with regulations. The assessment phase includes site identification, evaluation, prioritization, and proposed remedial actions. In many cases, data collection pertaining to groundwater, surface water, surface water sediments, and soil contamination is not sufficient to establish the required remedial action. Surface water and groundwater controls, leachate collection and treatment, control of contaminated sediments, and general maintenance of burial grounds are the remedial actions considered to control surface and subsurface water contamination.

Surface water controls are designed to reduce infiltration and runoff and to reduce erosion and stabilize the surface of waste disposal sites. Surface control measures include capping, grading, revegetation, and runoff diversion and/or collection systems.[14]

Groundwater controls are either passive or active. Passive controls include impermeable vertical barriers constructed of bentonite slurry, cement or chemical grouts, or sheet piling installed above grade to prevent groundwater from migrating through the site and thus prevent its contact with waste materials. Installation of up-gradient burial drains with the effluents being discharged into tributaries that flow away from contaminated areas is another potential passive measure. Pumping of groundwater and subsequent surface treatment is considered an active remedial measure. Groundwater pumping can be designed to lower the water table in a disposal site area, or it can be designed to contain a contaminated plume.[14]

Leachate collection systems generally consist of a series of drains that intercept the leachate and channel it to an appropriate treatment point. Another alternative is to minimize or prevent the generation of new leachate.[14]

Remedial techniques for contaminated sediments involve the removal and subsequent disposal or treatment of the sediments. Sources of contaminated sediments include sewers, creek beds, and drainage ways. Some sewer systems have become contaminated by infiltration of leachate or polluted groundwater through cracks, ruptures, or poorly sealed joints in piping. Remedial actions include in-place cleaning and repair or removal and replacement. Contaminated sediments in creek beds and drainage ways must be dredged and disposed of in an appropriate manner.[14]

Maintenance of burial grounds minimizes the potential for adverse impacts to the environment. General measures include keeping the surfaces clear of trees, filling cracks and depressions, and mowing regularly.[15]

Each of the three Energy Systems facil-

ities on the ORR is in the process of developing and implementing a remedial action program. ORNL discharges and disposal practices have contributed to the degradation of the water quality of White Oak Creek. The Y-12 Plant discharges have contaminated East Fork Poplar Creek and Poplar Creek. Bear Creek receives pollutant loadings originating from past disposal activities at the Bear Creek Valley Waste Disposal Area (BCVWDA) and seepage from the S-3 ponds. ORGDP operational activities have had an impact on Poplar Creek, although East Fork Poplar Creek contributes the majority of the pollutant loading of Poplar Creek. Determination of the extent of pollution is necessary before remedial measures are implemented. Data on groundwater and surface water contamination will provide details on the nature and the extent of the pollution. Groundwater movement, runoff patterns, and groundwater/surface water interrelationships are important in the selection of a remedial treatment method. Corrective actions will improve the water quality on the ORR and bring the facilities into compliance with regulations and DOE Order 4300.1A. Remedial actions are elaborated on in the long-range environmental management plans for the three ORR facilities[8,12,13] and other documents.[7,14-21]

4.2.4 Environmental Monitoring

Environmental compliance is a high-priority task at the three Energy Systems plants on the ORR. Each plant has a division responsible for monitoring the environmental effects of operations and compliance with environmental regulations. The programs that have been developed and maintained help to ensure the protection of water quality. Present and future monitoring programs on the ORR are described in Ref. 22.

There are five monitoring networks associated with operation of the facilities on the ORR: (1) within the boundaries of ORGDP, (2) within the boundaries of the Y-12 Plant, (3) within the boundaries of ORNL, (4) outside these plant boundaries and in the vicinity of Oak Ridge, and (5) off the ORR with stations extending from 30 to 193 km (19 to 120 miles) from the Oak Ridge area.

The water pollution control program involves monitoring for compliance with the NPDES permit system, which includes routine effluent monitoring for specific parameters and biological and toxicological monitoring. Groundwater monitoring is to be performed to provide information on the integrity of underground collection systems and waste tanks and for assessment of releases from solid and liquid waste disposal sites and other area sources of contamination. Through the monitoring of waste disposal sites, threats to the water supply from leaching and migration of contaminants can be detected. The air pollution control program indirectly serves to help protect water quality because airborne pollutants, which may eventually reach surface waters, are controlled and monitored.

Environmental surveillance networks protect water quality because contaminants to the water supply from surface water releases, releases to the groundwater, and airborne emissions can be detected. The monitoring can be divided into two categories: effluent and environmental. Effluent monitoring provides quantitative information that provides a basis for determining compliance with applicable regulations and the effectiveness of treatment systems. The environ-

mental monitoring program provides similar quantitative information on the environment into which the effluents are discharged. At present the environmental monitoring data collected are stored in a variety of forms and locations. The development of a long-range monitoring plan for the ORR has been suggested that would include an information system to provide a centralized database to which the three plants would have access.[23]

Monitoring of surface water discharges is primarily associated with compliance with the NPDES permit system. Each of the three facilities on the ORR is issued a separate NPDES permit; details of the environmental monitoring program for each plant can be found in Refs. 8, 12, and 13.

Groundwater monitoring system improvements must address the regulatory requirements outlined as part of RCRA and CERCLA. The RCRA requires groundwater monitoring around treatment, storage, and disposal facilities. Plans for upgrading the monitoring network will involve installation of RCRA-approved wells and implementation of a quality assurance sampling program. The groundwater monitoring network can be divided into three major categories: piezometric characterization, groundwater quality monitoring, and plume characterization.

The current groundwater monitoring system in Melton Valley consists of 100 wells, most of which are used to sample near-surface groundwater; there are, however, some deep wells. Some of the near-surface wells are sampled routinely but there are no routinely sampled deep wells that would give an indication of the true condition of the groundwater. Twenty-two additional RCRA-approved wells have been installed and up to 300 more will be added to aid in groundwater characterization.

Over 260 wells have been installed in the Y-12 Plant vicinity during the past 3 years. They are located in areas particularly susceptible to contamination including the oil landfarms, the S-2 and S-3 ponds areas, Kerr Hollow Quarry, and Rogers Quarry.

Assessments and characterizations of the ORGDP groundwater quality and flow are being performed. The issues of whether groundwater monitoring is necessary, the locations of the wells, and what analytical parameters are required are being addressed.

Environmental monitoring on the ORR serves to detect releases from the facilities into the surface and subsurface waters. Monitoring provides the data necessary to determine the extent of contamination and any changes in water quality and, in turn, for determining appropriate remedial actions. The increased monitoring capabilities are related to the overall strategy for the ORR to cover releases from all facilities.

5. RECOMMENDATIONS

5.1 WATER USAGE

The following actions are recommended for improvement to water usage:

- A centralized water resource information database should be established to provide ready access to information and to aid in planning measures that will ensure water quality protection and water conservation. A database has been proposed to consolidate environmental monitoring data, and a database is being developed for the remedial action program at ORNL. The development of a single water resource database that includes water consumption and discharge, environmental monitoring, and remedial action data could avoid duplication of effort.
- Flow meters should be installed at the points of major water use and at the locations where process water lines tie into the potable water system.
- Procedure and location requirements for backflow prevention valves must be followed to prevent cross contamination.
- Water line leaks must be identified and evaluated for corrective action.
- Effluents should be recycled where feasible. The recycling of cooling tower blowdown, even though water softening treatment facilities are required, is an excellent means of reducing the use of water as makeup for the cooling towers.

5.2 WATER QUALITY

The following recommendations are made regarding water quality protection and improvements:

- Sampling and monitoring of surface water and groundwater should be continued. It is critical to assess the quality of water on the ORR to determine the effectiveness of treatment and disposal methods and to determine whether remedial actions need to be implemented.
- Categorization, characterization, and monitoring of the waste streams generated on the ORR should be continued to determine the appropriate treatment and disposal measures necessary to ensure protection of water quality.
- Remedial action plans to improve the water quality on the ORR should be implemented. Corrective measures include improved burial ground practices, additional or improved groundwater and surface water monitoring capabilities, improvements to containment and collection systems, and replacement of ponds and lagoons with appropriate holding tanks.
- Adequate spill prevention and control procedures must be maintained to minimize losses of pollutants into the waterways.

5.3 DROUGHT MANAGEMENT

During periods of prolonged drought, it could be necessary to restrict water usage and waste discharges at the ORR facilities. Action plans have been prepared by the three ORR facilities in the event that temporary measures to reduce water usage must be employed.

The reduction of water flow in the receiving streams as a result of drought conditions creates an additional environmental concern because the dilution normally provided by the stream is minimized by reduced stream flow. Pollutant concentrations within the stream could increase as stream flow decreased, although in some instances, the discharge of treated wastewaters could actually supplement and improve water quality. In the event of extreme drought conditions, the curtailment of waste discharges to minimize environmental degradation would require a detailed review of each discharge stream.

5.3.1 Y-12 Plant Water Usage Curtailment Plan

The Y-12 Plant has emergency procedures available for necessary reduction of water usage. Implementation of Plan A would reduce water usage from the normal 34 million liters (9 million gallons) to an estimated 24.6 million liters (6.5 million gallons) per day. The plan would result in isolation of all buildings except those for weapons production, ORNL Biology Division facilities, steam plant, medical, cafeteria, change houses, and sanitary water services to certain buildings on a share basis.

In the event that it became necessary to reduce water usage even further, Plan B decisions concerning the shutdown of production activities and/or Biology Division would have to be made on a case-by-case basis by DOE. Through stoppage of all production and research activities, estimates are that it would be possible to reduce water usage at Y-12 to less than 7.6 million liters (2 million gallons) per day. Under these conditions emergency utilities (steam plant, fire main, power, etc.) would be maintained.

5.3.2 ORNL Water Usage Curtailment Plan

ORNL's drought management plan establishes priorities for reduction of service to conserve treated water. It is, however, essential to reserve approximately 7.6 million liters (2 million gallons) of water for fire protection purposes.[24]

(1) Air conditioning cooling towers in systems that provide building cooling for personnel comfort only: 340,000 liters (90,000 gallons) per day
Consequence—inconvenience to personnel

(2) Other nonessential usage: 265,000 liters (70,000 gallons) per day
Consequence—inconvenience to personnel

(3) Shops: 640,000 liters (70,000 gallons) per day
Consequence—possible equipment damage

(4) Large cooling towers for reactors and other programmatic usage: 5,700,000 liters (1,500,000 gallons) per day
Consequence—reactor shutdown, loss of experimental data, equipment damage

(5) Other programmatic usage, excluding "no shutoff" usage: 5,300,000 liters (1,400,000 gallons) per day
Consequence—equipment shutdown, computer work stoppage, damage to equipment, loss of experimental data

(6) "No shutoff" usage: 3,000,000 liters (770,000 gallons) per day
Consequence—equipment shutdown, loss of experiments, loss of utilities, loss of long-term data, equipment damage

(7) ORNL steam plant: 1,200,000 liters per day (300,000 gallons) per day
Consequence—loss of utilities, plant shutdown

5.3.3 ORGDP Water Usage Curtailment Plan

The drought management plan for ORGDP establishes priorities for reduction of service to conserve water.

(1) Discontinue fire water testing: 76,000 liters (20,000 gallons) per day
Consequence—none for the short term

(2) Administrative control of main plant usage: 227,000 liters (60,000 gallons) per day MGDP
Consequence—slight inconvenience to personnel

(3) Turn off once-through comfort cooling systems: 3,407,000 liters (900,000 gallons) per day
Consequence—increased inconvenience to personnel

(4) K-1037 cooling tower shutdown: 795,000 liters (210,000 gallons) per day
Consequence—work curtailment at AVLIS

(5) K-1650 cooling system shutdown and other once-through computer-cooling systems: 2,180,000 liters (576,000 gallons) per day
Consequence—elimination of CCF computer and any administrative data

(6) K-1232 chemical process: 193,000 liters (51,000 gallons) per day
Consequence—curtailment of

- Metals cleaning, uranium decontamination, development: 378,000 liters (100,000 gallons) per day
Consequence—work curtailment
- Steam production: 590,000 liters (156,000 gallons) per day
Consequence—no laundry, no cafeteria, no hot water in some change houses, impact on areas requiring humidity control
- Analytical labs: 378,000 liters (100,000 gallons) per day
Consequence—work curtailment

(7) Sanitary water plant: 8,063,000 liters (2,130,000 gallons) per day
Consequence—plant shutdown[25]

5.3.4 Action Strategies

The following actions are recommended regarding drought management:

- Each of the three Energy Systems facilities, the Y-12 Plant, ORNL, and the ORGDP, need to review their drought management plans.
- Actual water usage by the various systems, priority of shutoff, and the consequences of the shutoff of the water supply need to be reevaluated to ensure appropriate strategies in the event of prolonged drought.